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INVENTORY AND CONSISTENCY ANALYSIS OF POPULATION PROJECTIONS IN WESTERN CANADA

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I. Introduction

This report presents an inventory and analysis of population projections at the local and regional levels undertaken by various agencies in Western Canada. Population projections at the national and provincial levels are done by Statistics Canada at regular intervals. When we come to lower levels, population forecasts are not made or published by any single government or private agency. But for planning purposes, cities and Regional Planning Commissions need population projections. It is inevitable that governments at various levels will make their own forecasts of population. There is no guarantee that such projections will be in agreement with the provincial population totals published by Statistics Canada.

In the case of smaller cities and municipalities it is doubtful that they have the necessary expertise to undertake population projections. The purpose of the present study is to evaluate the methodology used by various agencies and city planning departments in making population projections. This will help the Ministry of State for Urban Affairs examine the feasibility and necessity of a nationwide consulting body to advise municipal governments with regard to population projections.

II. Method

Information for this study was gathered in two stages. First, a letter was sent to the planning departments of various cities. The same letter was sent to the municipal affairs office of each province.

In the letter, information regarding population projection, methodology, the frequency of population projection and the importance attached to population projection by the city or municipality in their planning was requested. They were also asked to respond to the idea of creating a nation-wide consulting body to advise cities and municipalities on population projection.

Personal interviews of the officials in charge of population projection of the cities of Vancouver, Edmonton, Regina, and Winnipeg were conducted (by the author). Departments of Municipal Affairs of each of the provinces were visited to assess the part played by them in estimating the population of the cities of their province.

Whenever there existed publication of the population projection of a city, an attempt was made to collect such publications and the methodology used in that population projection.

The response to the letters sent out was very encouraging. Most of the cities took great care in responding in detail to each of the questions raised. Most of them described the methodology used and included the available publications. A selected number of

illuminating and interesting responses from the cities, Regional Planning Commissions and the Departments of Municipal Affairs are attached in the appendix.

From these letters it can be seen that some of them had very strong opinions with regard to the possibility of having a national agency for consulting in the matters of population projection. It is also clear from the letters that there is no uniformity in the methodology or hypotheses used in the population projections. Even when the same method is mentioned by different agencies, it is not to be assumed that the procedures were identical. The methods are not described in detail and so it is not an easy task to identify the basic different methods and evaluate them.

In most of the responses that we got, no distinction has been made between population estimation and population projection. But technically there is a difference between population projection and population estimation for local areas. In general "population projection" relates to dates following the last census, usually for some future dates for which no data is available for size of population or on any other variable related to population. On the other hand, "population estimation" can refer to "intercensal estimate" or to "postcensal estimate". In intercensal estimation the objective is to estimate the population for a date which falls between two censuses, the data of which are available. The postcensal estimate refers to the estimate of a population following a census. Usually data on some

other auxilliary variables will be available for this date and these variables are made use of in the estimation procedure (Shryock, 1973).

III. Review of the Methods of Population Projection

(1) Mathematical Methods

In this method, typically, data of population size for the past several years alone is used. A mathematical curve is fitted to this time series data. Then this fitted curve is used to extrapolate the population of a future date.

If a straight line (which is the simplest of all curves) is fitted to the data, it is equivalent to assuming a constant rate of growth. This procedure may give a satisfactory result for short term projections. But, if this method is used for long term projection the figures will be very unreliable.

(2) Ratio Method

In this method the proportion of a city's population to the population of the province is examined on a time series. From the past trend, future proportions are estimated. These projected proportions are, in turn, multiplied by the province's population to yield the projected population of the city. This method assumes that population projections for the province are available. Saxena has used this method to project the populations of the districts of Maharastra, (Saxena, 1976). The crucial factor in this method is the knowledge of the probable redistribution of future populations which will affect the city's share of

future population. This redistribution is mainly affected by the internal migration of population.

(3) Cohort - Component Method

Following Shryock (1973) we have preferred to designate this method by the above name even though "cohort survival" is also an equally popular name for this method. There are several variations of this method. Here calculations are carried out for each sex and age-group. Usually the population is grouped into five year age intervals. If the interval of the age grouping is five years, the population can be projected only in steps of five years. The starting point of population projection, according to this method, is the population distribution by age and sex in a base year. The three components of population change (i.e. mortality, fertility and migration) are considered separately. From the past trends in age specific death rate is determined. An examination of cause specific death rates will be useful to assess the possibility of future reduction in mortality (see George, 1972). From the projected age specific death rates survival rates are calculated. An intermediate step in this process is the construction of life table. (The description of the methodology of population by some cities makes no mention of this step at all. This makes one wonder whether they have used the method correctly). These survival rates are applied to the corresponding age cohort to obtain the population in the next higher age group after five years (assuming that we are dealing with population grouped into five year intervals).

Fertility is also projected for the future years based on past experience and other relevant factors. These projected fertility rates are applied to get the births in the projection years.

The third component, migration, can be treated in two different ways. The migration can be projected as a rate or as the volume of net migration. The second method is more widely used than the first. It is necessary to assume or estimate the age distribtuion of the migrants. This may be problematic in the case of small areal units. In most cases the average age distribution in the past will be assumed to continue. The final projected population by age and sex is obtained by combining the effects of all three components. This process may be continued for any number of years to get the population composition at any future date. The accuracy of the projected figures will depend on the realization of the underlying assumptions. How closely these assumptions will be realised in the future, is always a question. Because of this uncertainty, it is customary to assume different levels of mortality, fertility and migration. This will lead to a set of population projections. Such projections may be be labelled as "low", "medium" and "high" projections.

This is the most widely used method in population projection. All demographers will agree that this method is superior to any other method. This has the advantage that the population composition of the projection can be obtained. Also the use of this method forces the analyst to explicit the underlying assumptions.

A variation of this cohort-component method is to use the survival ratios obtained from two consecutive censuses in the immediate past. These census survival ratios have the advantage of combining the effect of mortality and migration as one component. The method can be illustrated by an example. Suppose we wish to project the population to 1980. The population projection is done separately for each sex. Population age 20-24 in 1980 is obtained by using the following relationship:

$$P(1980, 20\text{-}24) = \frac{P(1975, 20\text{-}24)}{P(1970, 15\text{-}19)} \quad P(1975, 15 - 19)$$

Similarly other age groups are also dealt with. The population under age five is obtained by considering the birth rate.

This procedure is simpler than the one described earlier. It should also be judged inferior because the variations in census survival ratios attributable to migration in one intercensal period is being perpetuated without ever making clear the part played by the factor.

A slightly modified version of this procedure was used by B.C. Research group in the population projection for various subregions of British Columbia.

(4) Regression Method

The correlation between economic indicators and total population size could be used to project local population. An example of the use of this method is given in Shryock (p. 802). Basically the method involves the estimation of the regression of population on some

selected economic indicator and using the estimated regression equation for population projection. This, of course, assumes that it is possible to get forecasts of the economic indicators. Although this method may seem to be very promissing it has not been listed extensively. A variation of this method, in which the projection of housing units, was used by the City of Winnipeg for population projection.

IV. Evaluation of the Methodology Used by Different Agencies

The United Nations has compiled a list of principles for evaluating national population projections, (see United Nations, 1965). All the criteria enuntiated in the U.N. document are not applicable for the evaluation of regional population projections of Canada. Nevertheless, they have some recommendations which are useful in assessing the adequacy of the methodology applied in regional and local population projections.

It is recommended that the usefulness of a projection will vary with the time span involved. The long term population projection will be much more unreliable than a short term projection. It is desirable not to consider only the course of future events which appear to be more likely as judged from past experience, but also to take account of plausibility. As a rule it is useful to work out projections on the basis of several alternative assumptions. This will show the reliability of population projection and also the range within which the population may grow in the future. It is also desirable to

to publish results of population projection designated as "low", "medium" and "high". Among the different methods of population projections, the cohort-component method should be judged superior to others, especially when the population is projected to more than five years. Even in cohort-component method there are several variations. A constant level of mortality and a constant level of fertility for a long time is an unlikely possibility. Therefore, such assumptions for long term projection should be judged as inadequate. Future decline of mortality and decline or stabilisation of fertility should be incorporated in population projection. Now we will look at the projections made by different agencies and list the important features as well as the adequacy of the projection.

(1) The Ministry of State for Urban Affairs

The demographic research group of the Ministry of State for Urban Affairs has published population projections for the Census Metropolitan Areas. The method used is a modification of the cohort-component procedure. As far as can be judged, the methodology seems adequate. The treatment of mortality is less than what should be expected from such a venture. The mortality is assumed to be constant at the present level. Undoubtedly there will be an increase in the expectation of life in the next 25 years. Experts may disagree on the level of increment in the expectation of life.

(2) B.C. Research Council, (1975)

The British Columbia Research Council used the censal survival ratios for different age groups to project the population of school districts, municipalities and regions of British Columbia. The censal survival ratios were averaged using geometric means. These ratios are adjusted so that they will converge towards 1.0. They used the birth rate for the age group 20-34 to obtain the number of births. This is inferior to the procedure in which age-specific birth rates are employed. The main objection to the procedure employed by the B.C. Research Council is the implicit assumption about the future level of internal migration. It is included in the population projections as the factor affecting the censal survival ratios. It would have been better to use the cohort-component method in which assumptions about migration are explicit. Furthermore, one is left wondering what the underlying assumption about the future course of mortality is.

The conclusions derived in their projections are not accepted by all other agencies in Vancouver without criticism. The Greater Vancouver Regional District officials feel that their (B.C., Research Council's) projections for the Vancouver metropolitan area are too high. If the projected future size is accepted, it has been pointed out, it will imply that all available land in the Delta region will have to be converted into residential areas.

(3) Greater Vancouver Regional District

The planning commission of the Greater Vancouver Regional District has prepared (1975) population forecasts by applying the cohort survival method. Three different levels of migration and three levels of fertility are combined to obtain a set of population projections up to the year 1986. Even after carefully reading the technical write-up, one is left with the impression that they did not construct life tables or survival ratios to incorporate age-specific death rates into the projection process. The correct method is to construct a life table from the age-specific death rates and to calculate survival ratios from the life table. These survival ratios are to be used as multiplying factors to the enumerated population in order to advance the population from one period (or year) to the next.

(4) The Department of Housing of the Government of B.C.

The Department of Housing of the Government of B.C. has a study guide to be used by their municipalities. This study guide gives a method of estimating the future population of a municipality on the basis of the projected number of housing units. Each municipality is instructed to calculate the average number of persons per household from the data already available. This multiplier is applied to the projected number of households. This method is very crude and its accuracy will depend on the accuracy of the estimate of households.

(5) Kamloops

The city of Kamloops has been making population projections for the past 20 years. In the earliest period the growth rate of the

immediate past was used for this purpose. The projections were mainly used to estimate the utility demands in various municipal systems. In the recent years (last 2 to 3 years) attempts have been made to relate the population forecasts to the economic forecasts of the future employment trend. First, the employment trend is projected and a multiplier applied in order to get the total population. Two other methods of projection were pursued for checking purposes. One of the methods involved the projected population of the lower Mainland and of the interior centers and the observed relationship of their population with that of Kamloops. The other method was to use the growth rate of the past and to estimate the future population based on this growth rate. The projections are also checked with the results of the census and the data obtained from the household surveys in connection with the municipal election which takes place every two years. As a day-to-day means of following population trend between the enumerations, totals of building constructions are obtained and from these the total population is estimated. As long as the occupancy rate does not change, this method will give a satisfactory estimate of the current population.

They have not attempted any population projection on the basis of the cohort-survival technique. The use of growth rate is very crude indeed. The accuracy of population projection using employment trends and its relationship with population size will depend on two relationships: (i) the stability of the ratio of population to employment and (ii) the plausibility of the future employment trend. Since employment is only one of the multi-factors which influence the population size of

a city, this method cannot be universally used.

(6) Prince Rupert

Population is projected using the census data as the base line and a fixed annual increment. The estimate of the annual increase is revised every five years in conjunction with census data. The use of a fixed annual increase is inferior to the use of a fixed annual growth rate. The application of a constant annual increase implies that the population increases arithmetically. A geometric increase (implied in the use of fixed annual growth rate) is just as simple to apply but is more realistic.

(7) Kelowna

At present population projection is done using the growth rate observed in the recent past. The projection done by the planning department is supplemented by the projections done by other agencies (e.g. B.C. Research). In the future, the city is planning to use the cohort-survival method. They are also trying to establish a monitoring system so that the estimates can be revised on month-to-month basis.

(8) Regional District of Comox-Strathcona

The latest population projections were done in 1974. They have done population projections for school districts as well as for sub-areas. The sub-areas were formed so as to be of interest in subsequent studies. The population is projected to the year 2001 at five year intervals. Two different methods have been applied. For the school

districts, the projections were done using the cohort survival technique. For the sub-areas, growth rates were applied. In the cohort-survival method, a schedule of declining death rates and changing birth rates were applied. Three levels (low, average and high) of migration were assumed in the population projection. This led to three sets of projections. The method applied in projecting the population of school districts is good. The assumptions made are spelled out clearly and they are tenable. The high and low projections will be useful in considering alternate options in future planning.

The method used in the projection for sub-areas is not adequate. As the report points out, there are inconsistencies between the series of projections. This is the consequence of using an interior method for the sub-areas. So the projections for the sub-areas should be used with caution.

(9) Medicine Hat Regional Planning Commission

The Medicine Hat Regional Planning Commission makes population projections for municipalities within its boundary and also for the region as a whole. The methods applied are extrapolation of the present trend, cohort-survival, multipliers applied to employment trend and combinations of the above. The projections are revised after every quinquennial census. They prefer referring to these projections as "target populations". These targets may or may not be achieved at the specified date. The population projection for sub-area is done using "reasonable" growth rates. Alternate projections using higher

and lower growth rates are also made to study the impact of such eventualities. These projections are used to estimate the maximum and minimum requirements (in housing etc.) of the region.

(10) Edmonton

The City of Edmonton uses the cohort-survival method for population projection. In the latest publication by the city planning department (1974), population projections up to the year 2001 are given for the city of Edmonton as for the Edmonton sub-region. The population is projected in five year intervals. The sub-region includes the city and areas surrounding the city which interacts economically and socially with the city of Edmonton. Mortality is allowed to decline over the years and fertility is allowed to vary. Changes in the fertility rate are calibrated following a predicted course of total fertility. Survival ratios prepared for the provincial projection with slight upward adjustment (by a factor of 1.0009) were used. Unlike other cities, no other method was experimented with. The description of the application of cohort-survival method is detailed and we can way that the method was ocrrectly applied. The upward adjustment of survival ratios by multiplying the provincial figures by 1.0009 implies that the death rates of all age grouns are lower than those for the province as a whole. This assumption is not beyond reproach.

(11) Calgary

The latest population projections were prepared in 1975. Here the population is projected till the year 1996 at the interval of

five years. The method used is the cohort-survival technique. Three levels of fertility and three levels of migration are considered for projection purposes. From the descriptions of survival ratios one has to conclude that the age-specific death rate is taken as the survival ratio. There is no mention of the construction of a life table or about the relationship of the life table population to survival ratios.

(12) Calgary Regional Planning Commission

They do not undertake population projections for each of the municipalities under its juridiction at regular intervals. As a part of the Calgary Regional Growth Study (1975), population projections were prepared for sub-areas. The methodology was the same as the one (cohort-survival) applied by the city of Calgary. The criticisms raised against the application of this method in the case of Calgary is also applicable. Assumptions regarding the future level of migration were based on the actual migration experience between 1966-1971. For the municipalities with positive net migration, the annual migration was held constant. In the case of municipalities with a negative net migration, the net migration rate was held constant. This will result in a decrease of actual number of net migrants over time. Three levels of migration were included in the projections. The low level corresponds. to the observed level of migration in the period 1966-1971. The other two levels were double and triple the level of migration observed in the period 1966-1971. It is clear that the so called "low" projection on

the basis of this low migration does not represent a low projection. This, on the other hand, represents the continuation of the past trend. This method is likely to over estimate the population.

The population projections are undertaken on an application basis and no plan exists for setting up an ongoing system.

(13) Edmonton Regional Planning Commission

The Edmonton Regional Planning Commission has done relatively little in the area of population projection. However, they have done projections to 1981 for several major centers in their planning area. The projections were based on subjective assessment of recent growth and development trends and Statistics Canada data. In the near future, they are planning to commence work on detailed population projections. The methodology to be used is the cohort-survival technique, the trend analysis and the ratio-stepdown method.

They would like to have nationwide consulting body to advise municipalities on population projections. It was suggested that such a body should expand its base to include labour force and housing demands.

(14) Battle River Regional Planning Commission

In the past, they have occasionally done population projections. But they no longer attempt population projections. According to the Battle River Regional Planning Commission, it is pointless to prepare population projections for small towns. The major objection is based on the nature of migration. They consider any projection below the provincial level a waste of time.

(15) Peace River Regional Planning Commission

Occasionally they have done population projections for the region and for sub-areas. The projections have been rough and approximate. Estimates have been made on the basis of an annual percentage increase. One percent, 3 percent and 5 percent increase per annum were the assumptions underlying the low, medium and high projections. Very little reliance is placed on these projections. Because of the simplicity of the method used, one cannot hope to get any reliable population estimates in this manner. They are highly in favour of a nationwide or provincial body to advise on (or) to undertake population projections for cities and municipalities.

(16) Red Deer Regional Planning Commission

They have projected the population of the municipalities under their jurisdiction using long term growth rates. In the future, they plan to revise the population projection every five years. The Population Research Laboratory of the University of Alberta did population projections (1975) for the Red Deer Planning Commission using the cohort-survival method. Projections were made up to the year 1986 at five year intervals. They (the planning commission) do not want to rely on one method alone. They will, in the future, employ projections based on different growth rates.

(17) The City of Regina

Population projection is not done at regular intervals. The planning report of 1974 includes population projection up to the year 1991. The cohort-survival technique is used for this purpose. Birth

and death rates are assumed to remain constant. The effect of in-migration and out-migration is considered negligible because the net migration in 1971 was virtually insignificant. Past experience, according to the planning department, has shown that the migration to the city is related to the changes in the structure of the provincial economy. Instead of applying migration rates, a growing industrial component has been worked out into the population projection. A moments reflection will show that this "industrial component" is nothing but the migration component in another name. Two or three sets of population projections incorporating different levels of migration would be better than the present system adopted by them.

(18) Prince Albert

Population projections are prepared using the cohort-survival method and by linear extrapolation of past trends. Estimates are revised annually using the Saskatchewan Hospitalization plan data. After every census the estimates are revised using the census data. The method applied is good. Alternate projections using different assumptions about the components of population change, especially migration are not attempted and this should be considered a weakness.

(19) Department of Municipal Affairs - Saskatchewan

They undertake population projections for the municipalities. These projections are single purpose oriented. Therefore the estimates are not revised at regular intervals. The methodology includes extra-polation of trends, employment multiplier and cohort-survival. Data

from Saskatchewan hospitalization plan is used in the estimation of migration trends.

(20) City of Winnipeg

The Research division of the Department of Environmental Planning, City of Winnipeg is responsible for preparing population projections for the Winnipeg C.M.A. Projections are done for the C.M.A. and for the smaller geographical areas within the C.M.A. The cohort-survival technique is used to make population projections for the Metropolitan area up to the year 1996. The latest population projections were published in 1976. For smaller geographical areas, application for residential construction and the predicted future demand for housing in the areas are taken into consideration in the population forecasts. In an earlier population projection (1966), first the number of households were projected and then the population was projected using the average number of persons per household. The planning department considered the accurate projection of population to be an essential component of their planning requirement. It does not, however, see the necessity of a nationwide consulting body to advise cities on this matter. They feel they have the necessary expertise.

(21) Department of Municipal Affairs - Manitoba

The enquiries regarding the status of population projection sent to other cities (i.e. other than Winnipeg) in Manitoba were referred to the Department of Municipal Affairs. The municipal planning branch is responsible for the population projection of all cities except

Winnipeg metropolitan area. Even though not at regular intervals, population is projected for all major planning projects. The method applied depends on the size of the municipality. In the case of smaller municipalities, those with a population of approximately 1,000 projections are done on the basis of historical trends. Normally the projection is done for a period of ten years. In the case of larger urban municipalities, either the cohort-survival method or the geometrical rate of growth is used. It is pointed out that at the local planning level of smaller cities, very sophisticated methods of population projections are not necessary.

Review of Methods Used

The most often mentioned and applied method is the cohort-survival method. The use of a constant annual growth is the second most frequently mentioned method. Some of the cities use a multiplier factor with the predicted employment trend and housing trend. The accuracy of these two mentioned methods will depend on the accuracy with which employment or the number of households can be predicted. While applying the chort-survival technique, agencies differ in the assumptions they make about the future course of mortality, fertility and migration. Some of them use the same mortality schedule for the entire period of projection.

The Methods and the Number of Agencies Using that Method for Population Projection

Method	Number of Agencies Using the Method
Employment trend and multipliers	3
Multipliers applied to housing estimates	2
Fixed annual increment	1
Growth rate based on past trend	10
Regression method	1
Adjusted censal survival ratio	1
Cohort-survival method	15

(An agency is counted more than once if it uses more than one method)

This is definitely inferior to the use of a declining schedule of mortality. One argument for using a constant level of mortality is that any further decline of mortality will not have any significant effect on population growth. Another reason for using a constant level of mortality (even though not explicitly mentioned) is that it is easier to handle the population projection in this manner.

In any realistic population projection allowance should be made for changes in fertility and migration levels. The best way to handle this is to make a set of population projections combining different levels of these two factors. Several agencies have not done this.

The second most popular method, the application of a growth rate is not suitable for long range population projection. In this method and underlying assumptions about the components of population change are not known or not made explicit.

The most problematic factor in the population projection of cities is the future trend of migration. The study of migration between cities and their surrounding rural areas or between cities is not within the capability of any single city planning department.

The low, medium and high levels of migrations assumed by different cities are not comparable. Some use the current level of migration as the low level; others use the current level as the medium and so on.

V. Recommendations

1) A guideline for population projection should be prepared. Today there is no uniformity in the methodology used in population projections prepared by different agencies. Even when the same method is used by different cities it does not mean that there is uniformity or comparability. Some use a constant level mortality while others use a declining schedule of mortality. Furthermore, some use the method incorrectly. Consider the case where the growth rate is used to project population. One can use the average growth rate of the last five years or that of one year. The rate assumed may be very different according to the period considered.

2) A detailed description of the methods of population projections should be prepared and should be made available to all interested parties. Most cities claim that they have the necessary expertise to make population projection. A closer look at the methods used show that in several cases the correct method is not applied.

A computer program to prepare population projection using cohort-survival method will be very helpful for most cities. At present the work is being done at different centres independently. Only the larger cities can afford to use the cohort-survival technique at present because computer programs which are simple and easy to use are not available. Interactive programmes could also be developed for this purpose. Such programmes could be used by anyone who has access to a computer.

3) Efforts should be made to coordinate the population projections of different levels so that they will be in agreement with the provincial totals. At present, cities make population projection without any consideration being given to the provincial totals as projected by Statistics Canada. In some cases, it was seen that the same agencies prepare population projections for sub-areas which are inconsistent with projected population for the whole area prepared by the same agency.

4) Very few cities make use of the auxilliary information available on the variables of population in order to estimate and update population totals. Information on the methods of population estimation

using the vital rates method, the component method, the ratio-correlation method etc., should be made avilable to all cities so that they could use these methods to update their population estimates.

5) Channels of communication between agencies on the complexity of population projection should be opened. Today, cities and municipalities work in isolation on these matters. The Ministry of State for Urban Affairs must play a greater role in order to assure coordination between different agencies.

6) A nationwide consulting body should be instituted in order to advise cities on population projections and related areas. This body could also experiment with new methods and their applicability under varying conditions. For instance, this function could be coordinated by the Ministry of State for Urban Affairs jointly with Statistics Canada.

Among the 23 cities or agencies from whom a definite view on this matter was obtained, eight were of the opinion that it is not necessary to have such a consulting body. Several reasons were advanced for holding such opinion. Some of them felt it was a waste of time and tax payer's money while some felt they had the necessary expertise. Yet others thought that there are already enough consulting bodies at present.

Fifteen agencies gave strong or conditional approval for the creation of such a consulting body. Some of the smaller cities felt that it would be of great assistance. Such a body could help to prepare labour force projection and projection of housing needs.

7) Studies should be conducted on internal migration and its trend. Migration between rural and urban areas and between cities is one factor in the population size of most cities. The inability to predict the future levels of migration has been suggested as one of the major problems in the population projection for cities. Data from hospitalization and family allowance plans could be used to study the migration trends.

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